International Journal of Civil Engineering and Technology (IJCIET)
Volume 8, Issue 3, March 2017, pp. 1043–1048 Article ID: IJCIET_08_03_106
Available online at http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=3
ISSN Print: 0976-6308 and ISSN Online: 0976-6316

BEHAVIOUR OF M20 GRADE CONCRETE AT DIFFERENT TEMPERATURES

G. Durga Rama Naidu
Assistant Professor, Civil Engineering Department, AITAM College,
Srikakulam, Andhra Pradesh, India

P. Manoj Kumar
Assistant Professor, Civil Engineering Department, AITAM College,
Srikakulam, Andhra Pradesh, India

G. Prasanna Kumar
Assistant Professor, Civil Engineering Department, AITAM College,
Srikakulam, Andhra Pradesh, India

D. Hari Prasad
Teaching Assistant, Civil Engineering Department, AITAM College,
Srikakulam, Andhra Pradesh, India

ABSTRACT

The structural element subjected to high temperatures lead to significant losses due to the reduction in the strength of the concrete .with the mode toward urbanization, rate of construction and hazards related to it has increased to high extend. One such major source is fire accidents. Structure can undergo fire accident, but because of this the structure cannot be denied neither abandoned. To make a structure functionally viable after the damage due to fire has become a challenge for the civil engineering community. The problem is where to start and how to proceed. The root for such problem lies in the strength parametric study of component material that is used in construction industry. One such major item is concrete, which have very distinct chemical and physical properties because of its elemental components. The study done in this project is basically for M20 grade concrete subjected to various temperature and thus the changes in properties are marked and highlighted. This project aims to show the behavior of concrete at various temperature and changes in its compressive strength and physical properties. Results show mark able behaviors of concrete which make it further more topic of interest. Results show mark able behavior of concrete which makes it furthers more topic of interest. The study reveals that concrete has very distinct bonding properties that change with change in exposure conditions.

Key words: compressive strength, exposed conditions and temperature, non-destructive tests.

Cite this Article: G. Durga Rama Naidu, P. Manoj Kumar, G. Prasanna Kumar and D. Hari Prasad, Behaviour of M20 Grade Concrete at Different Temperatures. *International Journal of Civil Engineering and Technology*, 8(3), 2017, pp. 1043–1048.
http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=3

1. INTRODUCTION

Structural concrete is one of the most commonly used construction material in the world. Concrete elements exposed to fire experience temperature gradient and, as a result, undergo physical changes or spelling, there by exposing steel reinforcement. The structural property of concrete that has been most widely studied as a function of temperature exposure is compressive strength.

Concrete structure known for good fire resistance and have very often a very high residual strength. it is often both technically and economically possible to repair and reuse a concrete structure after fire. It is therefore important to be able to assess the state of the structure after fire as well as the load utilization degree in a professional way if the load utilization in fire situation is less than 100% which most often is the case this gives an extra load bearing reserve and an increased possibility for reuse of the member. However, some times the unexpected happens, i.e. early collapse and the reason why it happened is very important to investigate for avoiding future mistakes.

The study of the behavior of concrete at elevated temperature and rehabilitation and repair of structure has assumed great importance in recent times because the accumulated annual loss of fire and property due to fires is comparable to the loss caused by earthquake and cyclones. This necessitates development of fire-resistant design and proper repair of damage structures. A brief review of the existing literature on the behavior of cement concrete, and its constituents under elevated temperatures considering parameters like compressive strength is presented.

2. RESEARCH SIGNIFICANCE

The significance of the research is to study the effect of elevated temperatures up to 300^0C on concrete cubes. Nominal mix of mix proportion M20 is carried out. Concrete cubes of size 150mm×150mm×150mm were cast and cured for 28 days. After 28 days of curing, cubes were initially tested by rebound hammer. After testing, the specimens were individually subjected to temperature expose of 50 to 300^0C with increment of 50^0 each for 3 hour duration and were allowed to cool down to room temperature by air cooling method. Again the specimens were tested by rebound hammer. Then the cubes were tested in compressive strength.

3. MATERIALS AND PROPERTIES

Cement: RAMCO Portland Pozzolona Cement confirming to IS 1489-1991 of specific gravity 3.12.

Fine Aggregate: River sand confirming to Zone-III of IS 383.

Coarse Aggregate: Crushed granite metal with 60% passing 20 mm and retained on 10 mm sieve and 40% passing 10mm and retained on 4.75mm sieve was used.

Water: Potable water confirming to IS: 456-2000.

Table 1 Seive Analysis of fine aggregate.

IS sieve size	Weight retained	% Weight retained	FINE AGGREGATE		ZONE –III
			Cum.% retained	Cum. % passing	Range IS-383: 1970
10mm	0	0	0	100	100
4.75mm	12	0.4	0.4	99.6	90-100
2.36mm	33	1.1	1.5	98.5	85-100
11Emm	255	8.5	10.0	90.0	75-100
600µ	1250	41.6	41.6	58.4	60-79
300µ	1055	35.2	55.5	13.2	12-40
150µ	365	12.16	38.96	1.04	00-10
<150µ	25	0.83	99.79	0.21	

4. METHODOLOGY AND EXPERIMENTAL INVESTIGATION

Experimental study was performed in order to provide sufficient information about the strength characteristics of natural sand concrete of M20 grade at different temperatures and their comparison.

Non destructive tests such as Rebound hammer test were conducted on M20 grade concrete at different temperatures and results were analysed.

5. TEST RESULTS

Table 2 Variation of Compressive Strength of M20 Grade Concrete with respect to duration of curing.

No.of days of curing	Compressive strength for m20 grade concrete in (n/mm^2)	% of gain of strength
3	7.9	28.75
7	15.12	55
14	21.31	77.5
28	27.5	120

Table 3 Variation of average compressive strength of cube specimens with temperature by rebound hammer test at 28 days curing.

Specimen	Temperature (^{0}C)	% Variation of average compressive strength
1	27	100
2	50	98.83
3	100	95.87
4	150	129.27
5	200	97.93
6	250	94.86
7	300	93.87

Table 4 Variation of average compressive strength of cube specimens with temperature by compression testing machine

Specimen no.	Temperature (^{0}C)	% variation of average compressive strength
1	27	100
2	50	97.63
3	100	96.7
4	150	125.27
5	200	95.73
6	250	93.56
7	300	92.67

6. DISCUSSIONS

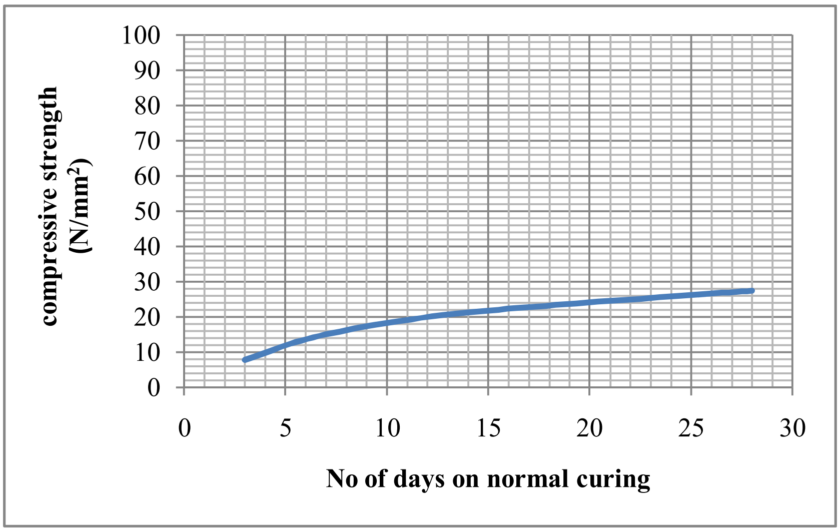

Figure 1 Variation of Compressive Strength of M20 Grade Concrete with respect to duration of curing.

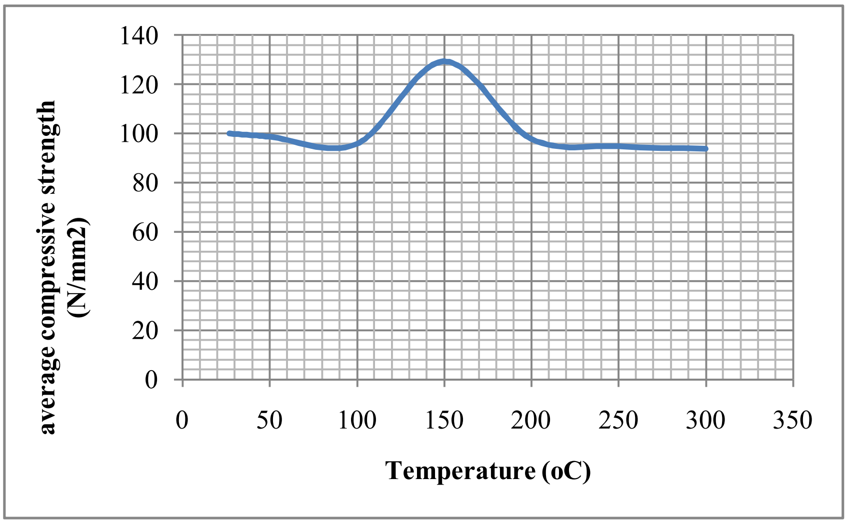

Figure 2 Variation of average compressive strength of cube specimens with temperature by rebound hammer test at 28 days curing.

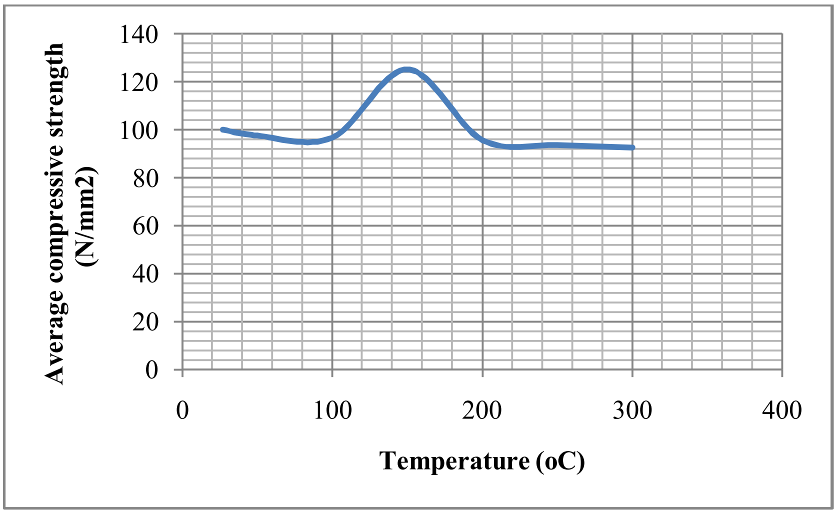

Figure 3 Variation of average compressive strength of cube specimens with temperature by compression testing machine

7. CONCLUSIONS

- There is no significant color change in the concrete cubes subjected to temperatures below 300^{0}C.
- The rebound hammer test results show that cubes exposed to temperature 50,100,150,200,250,300^{0}C exhibited residual compressive strengths of 98.83, 97.7, 127.27, 96.93, 95.86, 93.87% respectively.
- The compression test results show that cubes exposed to temperature 50,100,150,200,250,300^{0}C exhibited residual compressive strengths of 97.63, 96.75, 125.27, 95.73, 93.56, 92.67% respectively.
- Load carrying capacity of all the heated cubes was lower than that of companion cubes except at 150^{0}C.The compressive strength of cube increased due to proper hydration of cube at that particular temperature.
- The concrete used in the cubes maintained its structural integrity up to 300^{0}C.

REFERENCES

[1] Kodur, V. K. R., and M. A. Sultan. "Effect of temperature on thermal properties of high-strength concrete." Journal of materials in civil engineering 15.2 (2003): 101-107.

[2] Saad, M., et al. "Effect of temperature on physical and mechanical properties of concrete containing silica fume." Cement and Concrete Research 26.5 (1996): 669-675.

[3] Klieger, Paul. "Effect of mixing and curing temperature on concrete strength." Journal Proceedings. Vol. 54. No. 6. 1958.

[4] Malhotra, H. L. "The effect of temperature on the compressive strength of concrete." Magazine of concrete research 8.23 (1956): 85-94.

[5] Kim, Jin-Keun, Sang Hun Han, and Young Chul Song. "Effect of temperature and aging on the mechanical properties of concrete: Part I. Experimental results." Cement and Concrete Research 32.7 (2002): 1087-1094.

[6] Naus, Dan J. The Effect of Elevated Temperature on Concrete Materials and Structures-a Literature Review. No. ORNL/TM-2005/553. Oak Ridge National Laboratory (ORNL), 2006.

[7] Heikal, Mohamed. "Effect of temperature on the physico-mechanical and mineralogical properties of Homra pozzolanic cement pastes." Cement and Concrete Research 30.11 (2000): 1835-1839.

[8] Kim, J. K., Han, S. H., & Park, S. K. (2002). Effect of temperature and aging on the mechanical properties of concrete: Part II. Prediction model. Cement and Concrete Research, *32*(7), 1095-1100.

[9] Sallam, H.E.M. and Ibrahim, K.I.M. The Compressive Strength of Fiber Reinforced Concrete (FRC) at High Elevated Temperatures. *International Journal of Civil Engineering and Technology*, 6 (8), 2015, pp 53-60

[10] G. Prasanna Kumar, G. Durga Rama Naidu, P. Puspalatha, P. Manoj Kumar, An Experimental Study on Non-Destructive Tests and Stress Strain Curves of M20 Grade Concrete with Nano -Silica Using M-Sand. *International Journal of Civil Engineering and Technology,* 8(3), 2017, pp. 385–390.